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Review Article

A Research Review of Bilingual Language Switching and its Modulating Factors -

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ABSTRACT

Bilingual language switching can be better understood by taking it both as a subject and a method. To describe it, we review the models and hypotheses of Bilingual language switching, like inhibitory control model, language specific-selection hypothesis etc. We further discuss its modulating factors including factors of executive control, like working memory and language inhibition, language proficiency, age, and task-related factors. Factors interact with each other, so we suggest the future research to design strict experiments to reduce the influence of irrelevant factors. This review helps future research in the field of bilingual language switching to take further process by taking these factors into consideration, and also helps second language teaching and learning, especially interpreting teaching.

Keywords: Language Switching; Bilinguals; Switch Costs; Language Selection; Modulating Factors

ABBREVIATIONS

BLS: Bilingual Language Switching; ICM: Inhibitory Control Model; LSSM: Language-Specific Selection Model; WM: Working Memory; AOA: Age of Acquisition

INTRODUCTION

Bilingual Language Switching (BLS) is the process of switching from the use of one language to another [1]. In view of bilingual language selection, one of the most compelling finding to date is that bilinguals will coactivate both languages when they read, speak, or even when only one language is spoken [2-4]. However, in daily life, bilinguals can successfully and freely switch between two languages without much random errors [5,6]. So, what is the mechanism behind BLS to help bilinguals use languages freely?

In the process of language switching, researchers have found that comparing to the processing of a single language series, bilinguals in the process of processing a mixed language series tend to show longer reaction time and higher error rate. The costs within the process are termed as language switching costs [7-11]. Since then, language switching costs has been taken as an index of BLS. Based on this point, a plethora of empirical studies have been carried out at home and abroad [12-14]. And two hypotheses of "Language-specific Selection Hypothesis" [2] and "Language-nonspecific Selection Hypothesis" [15] have been gradually formed. The former believes that inhibition is the main reason for the costs of language switching, while the latter claims that language proficiency is the key to the language switching costs for bilinguals, which will be explained further in the next section.

Besides, in this review, we will focus on all the factors that modulates BLS. In this way, we hope the researchers carried on language switching could make further progress by taking these modulating factors into consideration, even solving some controversial issues. And as more empirical studies regard BLS as a method to step into bilingual advantages of executive function [16,17], it seems that understanding these factors is quite useful when design tasks or select participants in a study.

Through this review, we hope BLS can be better understood both as a subject and a method. The study on the source of language switching costs can enrich the researches in the field of language cognition, also explain BLS from the perspective of cognitive psychology. As a method, the study of modulating factors of BLS helps future researches and also benefits second language teaching and learning.

HYPOTHESES AND MODELS OF BLS

Language-nonspecific Selection Hypothesis and Inhibitory Control Model

Language-nonspecific Selection Hypothesis: In Meuter and Allport (1999), inhibition was first taken as an explanation of the asymmetry of switching costs in Bilingual Language Switching (BLS). In their research, participants were required to take a language naming task, asking them to name numbers according to the language clues. The research revealed that the response latencies in switch trials were longer than the non-switch trials, that is, the switching costs of BLS appears. And also, switch costs of dominant L1 to weaker L2 was smaller than weaker L2 to dominant L1, and the asymmetry of language switching costs occurs. To explain this phenomenon, researchers agreed that differences in the degree to which bilinguals inhibit two languages (one is dominant language, the other is weaker) during BLS. To be more specific, when dominant L1 switch to weaker L2, participants should first inhibit the L1, then activate L2. Similarly, when switching from L2 to L1, participants need spend more cognitive resources to restore L1 from its previously inhibited state to active state. Therefore, the different degrees of inhibition, resulting in asymmetrical switching costs. According to these results, Meuter and Allport believed that inhibition was quite significant in BLS and also proposed the inhibitory control hypothesis for BLS.

From then on, researchers proposed many theories in view of BLS, among which the language-nonspecific selection hypothesis" is the most representative one. The language-nonspecific selection hypothesis [15] demonstrates that in the process of words selection, both target words and unintended words may be activated and become candidates. Besides, selection is achieved through a top-down inhibitory mechanism outside the language system. In this way, the activation of unintended language is suppressed. The more unintended words are activated, the stronger it is inhibited. Dominant languages are more likely to be activated during language switching than nondominant languages. Under this account, when bilinguals switch between languages, switching into nondominant language will cost more efforts.

Inhibitory Control Model: In line with the research of language inhibition, Green (1998) proposed inhibitory control model (ICM), which was a typical model of language-nonspecific selection hypothesis. This model holds that the lexical choice of the two language systems is realized by inhibition mechanism, that is, by inhibiting the activation of unintended language, the selection of the target language is realized. [8,16]. It includes two hypotheses: first, the higher the proficiency of language, the more it is inhibited. During language switching, the degree of inhibition of dominant language will be greater than that of nondominant language; Secondly, reactivating the suppressed language is in direct proportion to the degree of inhibitory control. When unbalanced bilinguals switch from L2 to L1, the weaker L2 first inhibited the activation of L1, then it requires greater efforts to reactivate the dominant language, which will lead to language switching costs.

This model has been proved by lots of researchers [3,7], but also a great number of scholars reject it [18,19]. Whether or not ICM survives the test, it has been regarded as the most explanatory and influential theoretical model for the phenomenon of bilingual language switching costs. In recent years, inhibitory control has become a topic of great concern to many researches in bilingual field [20,21]. Green (1998)'s ICM is a top-down overall inhibition, which occurs in the whole language schema. Therefore, it may not be able to explain some type of language inhibition, and the range and degree of inhibition in BLS are still not clear enough.

Language-specific Selection Hypothesis and Language-specific Selection Model

Language-specific Selection Hypothesis: Until now, most of the evidence of inhibition existing in BLS come from low proficiency bilinguals [7,22-25]. For low proficiency bilinguals, their dominant L1 has a high proficiency, while L2 has a relatively low proficiency. Some researchers found out bilinguals with high proficiency did not show asymmetry switching costs [7,25,26]. Since two languages are similarly proficient, their activation levels are quite similar. When bilinguals switch between these two languages, the selection process and mechanism of words is similar to monolinguals. Therefore, no inhibition is needed and no switching costs, either. Hence, researchers proposed language-specific selection hypothesis to affirm the influence of language proficiency (specifically, L2 proficiency) on BLS and bilingual language switching costs.

For the language-specific selection hypothesis [2], it demonstrates that background information of both target and unintended languages may be activated, while words of unintended language are not candidates for selection. Therefore, the activation of target language will not be influenced by the unintended language when switching between languages. Bilinguals with high L2 proficiency access the target language more easily.

Language-specific Selection Model: Language-Specific Selection Model (LSSM) is the most influential model of language-specific selection hypothesis. It emphasizes language proficiency as the key factor modulating bilingual language switching costs. When the target language is accessed, the unintended words may also be activated. However, they will not be candidates for words selection later [2]. Bilinguals with high language proficiency of languages access and select language like monolinguals, while bilinguals with low language proficiency need to inhibit unintended words to achieve target words access. In the experiment of Meuter and Allport (1999), they also proved that language proficiency would influence the symmetry of BLS. Bilinguals with high language proficiency had symmetrical switching costs, while costs for bilinguals with low proficiency is asymmetrical. In addition, the studies also revealed that when switching from the dominant L1 to the less proficient L3, the switching costs of bilinguals with high proficiency were also symmetric [7,14]. To explain this phenomenon, [7] demonstrated that bilinguals with high proficiency may develop a new mechanism of language selection, and when they learn a new language, bilinguals will also take advantage of this mechanism. These experiments also indicate that when bilinguals with high proficiency switch between L1 and less proficient L3, they will not use inhibition to control language selection like bilinguals with low proficiency.

To sum up, the debate between ICM and ISSM mainly focus on where the language switching costs comes from. It is caused by language inhibition or language proficiency. Both theories have their own explanations and proofs. ICM mainly revolves around bilinguals with low proficiency, so it cannot explain the symmetrical switching costs of bilinguals with high proficiency. However, the asymmetrical switching costs also can be found in high-proficiency bilinguals [7,14]. Therefore, neither inhibition nor language proficiency are the only factors that affect bilingual language switching costs.

Language-specific Selection Threshold Model

[7] developed language-specific selection threshold model to reconcile these two kinds of opinions. This model agrees both the function of language inhibition and language proficiency and regards them as two stages of bilingual proficiency. Bilinguals with high proficiency may be able to make use of LSSM, without competition in language selection process. However, those less proficient bilinguals may not be able to avoid language competition. When select the target language, the unintended language will show up and become candidates for selection. As bilinguals speak languages in contexts, lexical access and selection in bilinguals should be a dynamic process. Thence, under some conditions, those language-nonspecific selection can be transformed into language-specific way. [27,28]. Therefore, some other factors may also affect the BLS, such as language contexts, working memory and so on.

MODULATING FACTORS IN BLS

Executive Control

Working Memory: Working Memory (WM) refers to a cognitive memory buffer with limited capacity for temporarily processing and storing information. It is an important basis for individuals to carry out advanced cognitive activities. In working memory, we need to hold current important information and the ability to add new information to improve it, or to remove or update previously retained information [29-31]. For one side, frequent switching between languages will enhance WM updating process [32]. On the other side, WM also affects BLS and language switching costs. According to Baddeley and Hitch (1974), a model of WM has three components and they are the central executive, the visuospatial sketchpad, and the phonological loop. Central executive exerts executive control determines the activities of two "slave systems" of the phonological loop (store and rehearse phonological representations) and the visuospatial sketchpad (form visual images). Three main components affect BLS in different ways [33]. The central executive system of WM has close relationship with language control in BLS as they activate parts of brain areas that are identical to each other [34]. In addition, the phonological loop can influence language switching by affecting the acquisition of new words in the second language [33,35]. The visuospatial sketchpad in working memory influences language switching costs by affecting text retention [36].

Inhibition: To explore the neural correlates of the language switching mechanism, many researches have been conducted between different languages and bilinguals. [22] investigated the neural mechanisms of language switching and task switching. It is found that in the phonological judgement task and the numerical judgement task, the right inferior frontal (rIFG) was more active in L1to L2 than in L2 to L1. This experiment confirmed the implication of ICM on BLS. Similarly, [37] used a picture naming task and observed the activation of rIFG when switching to L2 and L3. [16] trained the domain-general inhibition and examined its effects on performance in an overt picture naming task. Results indicated that bilinguals with low inhibitory control had symmetrical switching costs after training.

Moreover, in the posttest, the low inhibitory control group also showed a larger LPC (late positive component), which indicated the key role inhibition plays in BLS. Language switching experience trains inhibitory control, which in turn makes language switching more efficient. Based on this, researchers who agree with ICM propose that the reason why proficiency affects switching costs is because of language switching experience. High-proficiency bilinguals more frequently switch between languages, so their inhibitory control ability is trained, while low-proficiency bilinguals have poor control ability, so the switching costs are asymmetrical [21,27].

Recently, the domain-general control gets more attention, and how it is linked to language control has been widely discussed. Studies from ERP (event-related potentials) and fMRI show some overlap between them. Some ERP studies have found cognitive control-related N2 component in the process of BLS [26]. Brain imaging studies have also found a high degree of overlap between areas of the brain that are activated when switching between languages and those involved in general inhibitory control. The left dorsal prefrontal cortex and bilateral superior marginal gyrus activated by language switching are important components of the attention network of the frontal and parietal lobes [52]. The caudate nucleus and anterior cingulate gyrus are also involved in cognitive control [55]. Also, some researches proposed that the brain areas related to language control and general inhibitory control are partly overlapped [14]. Therefore, the relationship between them needs further study.

Language Proficiency

As we have mentioned above, Meuter and Allport (1999) noticed that high-proficiency bilinguals had symmetrical switching costs. Then, switching from the dominant L1 to weaker L3 also showed symmetrical costs. Based on these, Coast and Santesteban (2004) argued that bilinguals with high proficiency did not use inhibition, but develop a new mechanism to complete language access and selection.

Nowadays, many researchers take the method of neuroimaging and found that Language proficiency can influence areas of the brain involved in BLS. Mouthon et al. (2020) examined some important language control areas in language selection task. The participants were groups of student translators with high and moderate language proficiency levels. The results showed that L2 proficiency influenced the brain network involved in language selection, and when L2 proficiency improved, the network of language selection was more convergent with cognitive control network, which, in some extent, supports the influence of language proficiency on BLS. Abutalebi et al. (2013) examined the left caudate, one core region of language switching, in an overt picture-naming task. The results found that the left caudate varied with language proficiency, and switching between languages with different proficiency increased responses in this region. In a word, language proficiency plays a significant role in neural network of BLS. As there are still some different factors influencing the results of experiments, like language use, switching experience, age, future study can more extensively study the impact of language proficiency on bilingual switching neural networks by controlling variables strictly.

Age

The influence of age on BLS mainly involves two aspects. One is the difference in inhibitory control ability between older bilinguals and young bilinguals, and the other aspect is the influence of age of acquisition (AOA), which means the starting age of learning a second language.

The difference of inhibitory ability between the old bilinguals and the young bilinguals is mainly found in the task of measuring inhibitory control ability, like Stroop task and Simon task [6,53]. Van der Elst et al. tested 1856 participants from the age of 24 to 81 in Stroop test and the results showed that the response time increased with age, which means the inhibitory control ability decreased. [38] measured the performance of two age groups, old age (60 to 71) and middle age (40 to 55) in both Stroop task and Simon task, and the results also showed the age affected the control ability. As ICM proposed the inhibitory control outside languages, the influencing factor of age on inhibitory control also confirms its effect on BLS.

AOA also affects BLS by influencing inhibitory control. Theoretically, the critical period theory believes that acquiring two languages at an early age can expand the cognitive advantage of bilinguals in solving tasks [28]. From empirical studies, some studies demonstrated that only early bilinguals showed greater cognitive advantage than monolinguals, but the late bilinguals did not. [39] revealed that early bilinguals exhibited smaller flanker costs. In contrast, the flanker costs of late bilinguals were comparable to that of monolinguals. The results indicated that compared to monolinguals, early bilinguals showed better inhibitory control ability than late bilinguals. [40] found older bilinguals had better performance in Simon task than older monolinguals, while among the young, no control advantage was found between bilinguals and monolinguals. One reason to explain this result may be the time of language experience. The cognitive control develops as language experience increases. Therefore, whether AOA affects inhibitory control and BLS is still a question. The factor of AOA is closely related to language proficiency or language proficiency, so the future research should notice these confounding factors.

Task Design

Task Difficulty: In Tarłowski et al. (2013), Polish-English unbalanced bilinguals were asked to perform two tasks by switching between languages. One was describing pictures which showed ongoing and completed actions, and the other was to complete the progressive and perfective phrases of the subject-verb sentence. It is found that the switching costs of perfective phrases were symmetrical, and the switching costs of progressive phrases were asymmetrical, which indicated that task difficulty influenced BLS.

Preparation Time: Most of the studies observing language switching in bilinguals adopt behavioral experiments and mainly focus on the language switching paradigm of picture naming and digit naming [18,38,54]. Verhoef et al. (2009) examined Dutch-English non-balanced bilinguals in the picture naming task. And it found that the language switching costs were asymmetric when the preparation time was short (750ms). However, this asymmetry disappeared at longer intervals (1500ms). Based on Verhoef, Fink and Goldrick (2015) controlled the language proficiency of bilinguals, and studied the language switching costs with preparation time of 0ms, 750ms and 1500ms respectively by using digit naming task. The results showed that for non-balanced bilinguals, the preparation time did not affect the asymmetry of language switching costs. Similarly, [41] set the preparation time as 0ms, 500ms and 800ms, and also found no disappearance of language switching costs asymmetry. [33] found that the language switching costs of the unbalanced Chinese-English bilinguals decreased as the preparation time increased

during the picture naming task in 500ms and 800ms. Based on these experiments, it can be said that preparation time can affect language switching costs, and that how long the preparation time is, the asymmetry of switching costs will disappear is still under controversy.

Language Context: Most studies used a fixed ratio of switching tokens and non-switching tokens for studying language switching. But obviously, bilinguals did not speak languages in a certain ratio. [42] examined BLS by using a cued picture-naming task. In this task, participants performed in variable contexts which were placed in a continuum. The results found that in a more monolingual context, the language switching costs were asymmetrical, while in a bilingual context, the switching costs were symmetrical. In a cued-switching paradigm, language context can manipulate switching costs.

BLS is mostly studied in cued-switching paradigm, like picture naming paradigm and digit naming paradigm. However, bilinguals in their daily life switch freely. Therefore, many researchers turn to study in voluntary-switching paradigm. [43] conducted a study on voluntary language switching among Spanish-English bilinguals. The results revealed that switching sometimes facilitates responses as it occurs voluntarily, even responses in balanced bilinguals. In [44], participants were asked to name cued pictures, either monolingual cued or bilingual voluntary cued. The authors observed that contrary to the point that language switching is effortful, when participants responded to natural cues, switching is costless. Also, for bilingual voluntary conditions, the Anterior Cingulate Cortex (ACC) and Dorsolateral Prefrontal Cortex (dlPFC), manipulating language and cognitive control, were not activated. All findings demonstrated that voluntary switching had no switching costs.

[45-55] examined Spanish-Basque bilinguals in voluntary task and found switching costs. Therefore, how voluntary switching affect costs are still unknown and whether it needs a top-down control is also a question.

CONCLUSION

In this review article, we discussed the theoretical models and two hypotheses of BLS. Regarding the source of bilingual switching costs, the language-nonspecific selection hypothesis and ICM agree that inhibition played a role; the language-specific selection hypothesis and ISSM suggest that proficiency. To reconcile these two different opinions, language-specific selection threshold model has been proposed, which regards two hypotheses as two stages of language development. All models and hypothesis have something they cannot explain, and as more and more studies of BLS based on inhibition or inhibitory control, it is necessary to combine ideas of different models to explain language phenomenon.

Secondly, Factors affect each other and the function of some factors are still not clear. So, in the future, more studies should take on studying modulating factors, and have a restrict experiment design to reduce the influence of irrelevant factors.

Thirdly, WM and age influence the BLS by affecting cognitive control. Is there any direct relationship between BLS and cognitive factorsAre these factors trained and enhanced by tasks in experiments? Future research should design more effective experimental designs to study the specific relationship between inhibition control and WM in language switching and its applicable scope.

REFERENCES

1. Kolers PA. Interlingual facilitation of short-term memory. Journal of Verbal Learning and Verbal Behavior. 1966;5:314–319. https://www.sciencedirect.com/science/article/abs/pii/S0022537166800373
2. Costa A, Miozzo M, Caramazza A. Lexical Selection in Bilinguals: Do Words in the Bilingual's Two Lexicons Compete for Selection? Journal of Memory and Language. 1999;41:365-397. https://psycnet.apa.org/record/1999-01034-004
3. Hermans D, Bongaerts T, De Bot K, Schreuder R. Producing words in a foreign language: Can speakers prevent interference from their first language? Bilingualism: Language and Cognition. 1998;1:213-229. https://psycnet.apa.org/record/1999-11817-011
4. Spivey MJ, Marian V. Cross talk between native and second languages: Partial activation of an irrelevant lexicon. Psychological Science. 1999;10:281-284. https://journals.sagepub.com/doi/10.1111/1467-9280.00151
5. Myers-Scotton C. Contact linguistics: Bilingual encounters and grammatical outcomes. Oxford: Oxford University Press. 2002. https://oxford.universitypressscholarship.com/view/10.1093/acprof:oso/9780198299530.001.0001/acprof-9780198299530
6. Poulisse N, Bongaerts T. First language use in second language production. Applied Linguistics. 1994;15:36-57. https://academic.oup.com/applij/article-abstract/15/1/36/150059
7. Costa A, Santesteban M. Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners. Journal of Memory and Language. 2004;50:491-511. https://www.sciencedirect.com/science/article/abs/pii/S0749596X04000191
8. Declerck M, Philipp AM. A review of control processes and their locus in language switching. Psychon Bull Rev. 2015 Dec;22(6):1630-1645. doi: 10.3758/s13423-015-0836-1. PMID: 25917142.
9. Meuter R, Allport A. Bilingual language switching in naming: Asymmetrical costs of language selection. Journal of Memory and Language. 1999;40:25-40. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.568.7988&rep=rep1&type=pdf
10. Mishra RK, Singh N. Language non-selective activation of orthography during spoken word processing in Hindi-English sequential bilinguals: An eye tracking visual world study. Reading and Writing. 2014;27:129–151. https://psycnet.apa.org/record/2013-10059-001
11. Thomas MSC, Allport A. Language switching costs in bilingual visual word recognition. Journal of Memory and Language. 2000;43:44–66. https://www.sciencedirect.com/science/article/abs/pii/S0749596X99927006
12. Abutalebi J, Green DW. Control mechanisms in bilingual language production: Neural evidence from language switching studies. Language and Cognitive Processes. 2008;23:557–582. https://www.tandfonline.com/doi/abs/10.1080/01690960801920602
13. Calabria M, Hernández M, Branzi FM, Costa A. Qualitative Differences between Bilingual Language Control and Executive Control: Evidence from Task-Switching. Front Psychol. 2012 Jan 13;2:399. doi: 10.3389/fpsyg.2011.00399. PMID: 22275905; PMCID: PMC3257869.
14. Costa A, Santesteban M, Ivanova I. How do highly proficient bilinguals control their lexicalization process? Inhibitory and language-specific selection mechanisms are both functional. J Exp Psychol Learn Mem Cogn. 2006 Sep;32(5):1057-1074. doi: 10.1037/0278-7393.32.5.1057. PMID: 16938046.
15. Green DW. Mental control of the bilingual lexico-semantic system. Bilingualism: Language and Cognition. 1998;1:67-81. https://psycnet.apa.org/record/1999-11816-001
16. Liu H, Liang L, Dunlap S, Fan N, Chen B. The effect of domain-general inhibition-related training on language switching: An ERP study. Cognition. 2016 Jan;146:264-276. doi: 10.1016/j.cognition.2015.10.004. Epub 2015 Nov 9. PMID: 26491833.
17. Timmer K, Calabria M, Costa A. Non-linguistic effects of language switching training. Cognition. 2019 Jan;182:14-24. doi: 10.1016/j.cognition.2018.09.001. Epub 2018 Sep 11. PMID: 30212652.
18. Finkbeiner M, Gollan TH, Caramazza A. Lexical access in bilingual

speakers: What's the (hard) problem? Bilingualism: Language and Cognition. 2006;9:153-166.

19. Roelofs A. Bilingualism: Language and Cognition Lemma selection without inhibition of languages in bilingual speakers.. 1998;1:94-95. http://www.socsci.ru.nl/ardiroel/BLC1998.pdf

20. Bobb SC, Wodniecka Z. Language switching in picture naming: What asymmetric switch costs (do not) tell us about inhibition in bilingual speech planning. Journal of Cognitive Psychology. 2013;25:568-585. https://www.tandfonline.com/doi/abs/10.1080/20445911.2013.792822

21. Declerck M, Ivanova I, Grainger J, Dunabeitia JA. Are similar control processes implemented during single and dual language production? Evidence from switching between speech registers and languages. Bilingualism-Language and Cognition. 2020;23:694-701.

22. Hosoda C, Hanakawa T, Nariai T, Ohno K, Honda M. Neural mechanisms of language switch. Journal of Neurolinguistics. 2012;25:44-61.

23. Liu H, Tong J, de Bruin A, Li W, He Y, Li B. Is inhibition involved in voluntary language switching? Evidence from transcranial direct current stimulation over the right dorsolateral prefrontal cortex. Int J Psychophysiol. 2020 Jan;147:184-192. doi: 10.1016/j.ijpsycho.2019.12.002. Epub 2019 Dec 9. PMID: 31830498.

24. Macizo P, Bajo T, Paolieri D. Language switching and language competition. Second Language Research. 2012;28:131-149.

25. Verhoef K, Roelofs A, Chwilla DJ. Role of inhibition in language switching: evidence from event-related brain potentials in overt picture naming. Cognition. 2009 Jan;110(1):84-99. doi: 10.1016/j.cognition.2008.10.013. Epub 2008 Dec 12. PMID: 19084830.

26. Linck JA, Schwieter JW, Sunderman G. Inhibitory control predicts language switching performance in trilingual speech production. Bilingualism-Language and Cognition. 2012;15:651-662. https://pdfs.semanticscholar.org/c8d3/056d74aba81e1accbb340c2b5d95fd224b07.pdf

27. Grosjean F. Speech production. In F Grosjean, P Li. The psycholinguistics of bilingualism. Oxford: England: Wiley-Blackwell. 2013;50–69. https://www.wiley.com/en-in/The+Psycholinguistics+of+Bilingualism-p-9781444332797

28. Kheder S, Kaan E. Lexical selection, cross-language interaction, and switch costs in habitually codeswitching bilinguals. Bilingualism: Language and Cognition. 2019;22:569-589.

29. Baddeley A. Working Memory: The Interface between Memory and Cognition. J Cogn Neurosci. 1992 Summer;4(3):281-288. doi: 10.1162/jocn.1992.4.3.281. PMID: 23964884.

30. Linck JA, Osthus P, Koeth JT, Bunting MF. Working memory and second language comprehension and production: a meta-analysis. Psychon Bull Rev. 2014 Aug;21(4):861-883. doi: 10.3758/s13423-013-0565-2. PMID: 24366687.

31. Shipstead Z, Redick TS, Engle RW. Is working memory training effective? Psychol Bull. 2012 Jul;138(4):628-654. doi: 10.1037/a0027473. Epub 2012 Mar 12. PMID: 22409508.

32. López-Penadés R, Sanchez-Azanza VA, Aguilar-Mediavilla E, Buil-Legaz L, Adrover-Roig D. Associations of natural language switching with executive control in early bilinguals. Bilingualism: Language and Cognition. 2020;1-12. https://ouci.dntb.gov.ua/works/lRoZ3Gk9/

33. Chang X, Bai H, Wang P. The influenced factors of bilinguals' language switching costs. Advances in Psychological Science. 2017;25:1469-1478.

34. Hirsch P, Declerck M, Koch I. Exploring the functional locus of language switching: evidence from a PRP paradigm. Acta Psychol (Amst). 2015 Oct;161:1-6. doi: 10.1016/j.actpsy.2015.07.010. Epub 2015 Aug 13. PMID: 26280496.

35. Martin KI, Ellis NC. The roles of phonological short-term memory and working memory in L2 grammar and vocabulary learning. Studies in Second Language Acquisition. 2012;34:379-413. https://www.jstor.org/stable/26328949

36. Baddeley A. Working memory: looking back and looking forward. Nat Rev Neurosci. 2003 Oct;4(10):829-839. doi: 10.1038/nrn1201. PMID: 14523382.

37. de Bruin A, Roelofs A, Dijkstra T, Fitzpatrick I. Domain-general inhibition areas of the brain are involved in language switching: fMRI evidence from trilingual speakers. Neuroimage. 2014 Apr 15;90:348-359. doi: 10.1016/j.neuroimage.2013.12.049. Epub 2013 Dec 30. PMID: 24384153.

38. Billig JD, Scholl AP. The impact of bilingualism and aging on inhibitory control and working memory. Organon. 2011;26:39-52.

39. Luk G, De SE, Bialystok E. Is there a relation between onset age of bilingualism and enhancement of cognitive control? Bilingualism: Language and Cognition. 2011;14:588-595.

40. Lee Salvatierra J, Rosselli M. The effect of bilingualism and age on inhibitory control. International Journal of Bilingualism. 2010;15:26-37. https://www.researchgate.net/publication/254098745_The_effect_of_bilingualism_and_age_on_inhibitory_control

41. Ma F, Li S, Guo T. Reactive and proactive control in bilingual word production: An investigation of influential factors. Journal of Memory and Language. 2016;86:35-59. https://www.sciencedirect.com/science/article/abs/pii/S0749596X1500100X

42. Olson DJ. The gradient effect of context on language switching and lexical access in bilingual production. Applied Psycholinguistics. 2016;37:725-756. https://docs.lib.purdue.edu/lcpubs/9/

43. Gollan TH, Ferreira VS. Should I stay or should I switch? A cost-benefit analysis of voluntary language switching in young and aging bilinguals. J Exp Psychol Learn Mem Cogn. 2009 May;35(3):640-665. doi: 10.1037/a0014981. PMID: 19379041; PMCID: PMC2864120.

44. Blanco-Elorrieta E, Pylkkänen L. Bilingual Language Switching in the Laboratory versus in the Wild: The Spatiotemporal Dynamics of Adaptive Language Control. J Neurosci. 2017 Sep 13;37(37):9022-9036. doi: 10.1523/JNEUROSCI.0553-17.2017. Epub 2017 Aug 16. PMID: 28821648; PMCID: PMC5597983.

45. de Bruin A, Samuel AG, Dunabeitia JA. Voluntary language switching: When and why do bilinguals switch between their languages? Journal of Memory and Language. 2018;103:28-43. https://www.sciencedirect.com/science/article/abs/pii/S0749596X18300652

46. Abutalebi J, Della Rosa PA, Ding G, Weekes B, Costa A, Green DW. Language proficiency modulates the engagement of cognitive control areas in multilinguals. Cortex. 2013 Mar;49(3):905-911. doi: 10.1016/j.cortex.2012.08.018. Epub 2012 Sep 1. PMID: 23021069.

47. Baddeley A, Hitch G. Working memory. In G. H. Bower. The psychology of learning and motivation: advances in research and theory. New York: Academic Press. 1974:47-89. https://www.sciencedirect.com/bookseries/psychology-of-learning-and-motivation/vol/49/suppl/C

48. de Bruin A, Roelofs A, Dijkstra T, Fitzpatrick I. Domain-general inhibition areas of the brain are involved in language switching: fMRI evidence from trilingual speakers. Neuroimage. 2014 Apr 15;90:348-359. doi: 10.1016/j.neuroimage.2013.12.049. Epub 2013 Dec 30. PMID: 24384153

49. Fink A, Goldrick M. Pervasive benefits of preparation in language switching. Psychon Bull Rev. 2015 Jun;22(3):808-814. doi: 10.3758/s13423-014-0739-6. PMID: 25257712.

50. Richter FR, Yeung N. ERP Correlates of Encoding Success and Encoding Selectivity in Attention Switching. PLoS One. 2016 Dec 1;11(12):e0167396. doi: 10.1371/journal.pone.0167396. PMID: 27907075; PMCID: PMC5131936.

51. Kang C, Ma F, Guo T. The plasticity of lexical selection mechanism in word production: ERP evidence from short-term language switching training in unbalanced Chinese–English bilinguals. Bilingualism: Language and Cognition. 2018;21:296-313. https://psycnet.apa.org/record/2018-09090-008

52. Kaushanskaya M, Marian V. Bilingual Language Processing and Interference in Bilinguals: Evidence from Eye Tracking and Picture Naming. Language Learning. 2007;57:119-163. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-9922.2007.00401.x

53. Mouthon M, Khateb A, Lazeyras F, Pegna AJ, Lee-Jahnke H et al. Second-language proficiency modulates the brain language control network in bilingual translators: an event-related fMRI study. Bilingualism: Language and Cognition. 2020;23:251-264. https://dialnet.unirioja.es/servlet/articulo?codigo=7255972

54. Toro R, Fox PT, Paus T. Functional coactivation map of the human brain. Cereb Cortex. 2008 Nov;18(11):2553-9. doi: 10.1093/cercor/bhn014. Epub 2008 Feb 21. PMID: 18296434; PMCID: PMC2567424.

55. Van der Elst W, Van Boxtel MP, Van Breukelen GJ, Jolles J. The Stroop color-word test: influence of age, sex, and education; and normative data for a large sample across the adult age range. Assessment. 2006 Mar;13(1):62-79. doi: 10.1177/1073191105283427. PMID: 16443719.